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SOURCE PROVENANCE OF OBSIDIAN PALEOINDIAN AND EARLY ARCHAIC ARTIFACTS FROM THE GREAT BASIN

by

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INTRODUCTION

The analysis here of 36 Paleoindian and Early Archaic obsidian polyhedral cores, blades and bifaces from the North American Great Basin indicates a very diverse provenance assemblage throughout western North America. The XRF analysis was performed at the Geoarchaeological XRF Laboratory in Albuquerque, New Mexico, and the sources assignments were made by Craig Skinner, Director of the Northwest Research Obsidian Studies Laboratory, Corvallis, Oregon with a much more appropriate data base for Great Basin sources (see discussion).

LABORATORY SAMPLING, ANALYSIS AND INSTRUMENTATION

All archaeological samples are analyzed whole. The results presented here are quantitative in that they are derived from "filtered" intensity values ratioed to the appropriate x-ray continuum regions through a least squares fitting formula rather than plotting the proportions of the net intensities in a ternary system (McCarthy and Schamber 1981; Schamber 1977). Or more essentially, these data through the analysis of international rock standards, allow for inter-instrument comparison with a predictable degree of certainty (Hampel 1984; Shackley 2011).

All analyses for this study were conducted on a ThermoScientific *Quant'X* EDXRF spectrometer, located in the Geoarchaeological XRF Laboratory, Albuquerque, New Mexico, equipped with a thermoelectrically Peltier cooled solid-state Si(Li) X-ray detector, with a 50 kV, 50 W, ultra-high-flux end window bremsstrahlung, Rh target X-ray tube and a 76 µm (3 mil) beryllium (Be) window (air cooled), that runs on a power supply operating 4-50 kV/0.02-1.0 mA at 0.02 increments. The spectrometer is equipped with a 200 l min^{-1} Edwards vacuum pump, allowing for the analysis of lower-atomic-weight elements between sodium (Na) and titanium (Ti). Data acquisition is accomplished with a pulse processor and an analogue-to-digital converter. Elemental composition is identified with digital filter background removal, least squares empirical peak deconvolution, gross peak intensities and net peak intensities above background.

The analysis for mid Zb condition elements Ti-Nb, Pb, Th, the x-ray tube is operated at 30 kV, using a 0.05 mm (medium) Pd primary beam filter in an air path at 200 seconds livetime to generate x-ray intensity Kα-line data for elements titanium (Ti), manganese (Mn), iron (as $Fe_2O_3^T$), cobalt (Co), nickel (Ni), copper, (Cu), zinc, (Zn), gallium (Ga), rubidium (Rb), strontium (Sr), yttrium (Y), zirconium (Zr), niobium (Nb), lead (Pb), and thorium (Th). Not all these elements are reported since their values in many volcanic rocks are very low. Trace element intensities were converted to concentration estimates by employing a least-squares calibration line ratioed to the Compton scatter established for each element from the analysis of international rock standards certified by the National Institute of Standards and Technology (NIST), the US. Geological Survey (USGS), Canadian Centre for Mineral and Energy Technology, and the Centre de Recherches Pétrographiques et Géochimiques in France (Govindaraju 1994). Line fitting is linear (XML) for all elements. When barium (Ba) is analyzed in the High Zb condition, the Rh tube is operated at 50 kV and up to 1.0 mA, ratioed to the bremsstrahlung region (see Davis 2011; Shackley 2011). Further details concerning the petrological choice of these elements in Southwest obsidians is available in Shackley (1988, 1995, 2005; also Mahood and Stimac 1991; and Hughes and Smith 1993). Nineteen specific pressed powder standards are used for the best fit regression calibration for elements Ti-Nb, Pb, Th, and Ba, include G-2 (basalt), AGV-2 (andesite), GSP-2 (granodiorite), SY-2 (syenite), BHVO-2 (hawaiite), STM-1 (syenite), QLO-1 (quartz latite), RGM-1 (obsidian), W-2 (diabase), BIR-1 (basalt), SDC-1 (mica schist), TLM-1 (tonalite), SCO-1 (shale), NOD-A-1 and NOD-P-1 (manganese) all US Geological Survey standards, NIST-278 (obsidian), U.S. National Institute of Standards and Technology, BE-N (basalt) from the Centre de Recherches Pétrographiques et Géochimiques in France, and JR-1 and JR-2 (obsidian) from the Geological Survey of Japan (Govindaraju 1994).

The data from the WinTrace software were translated directly into Excel for Windows and SPSS software for statistical manipulation. In order to evaluate these quantitative determinations, machine data were compared to measurements of known standards during each run. RGM-1 a USGS rhyolite standard is analyzed during each sample run for obsidian artifacts to check machine calibration (Table 1). Source standards from Albuquerque were sent to Corvallis for inter-instrument calibration. Most of the elements were statistically similar enough so that we feel confident the source assignments are valid. The two laboratories have collaborated frequently over the last two decades.

Discussion

Craig Skinner's comments regarding source assignment:

See the attached spreadsheet (Table 1 here) for my best call on the sources. Generalized maps showing their locations should all be available through: http://www.obsidianlab.com/image_maps/index.html

- Rock Canyon I: An obscure source located near the Utah border west of St. George. It usually shows up in collections from SW Utah but a BLM guy finally found it in NV a couple of years ago.

- BS/PP/FM: I lump these all together into one combined group although Richard still likes to split them up.

- China Lake Unknown A: A curiously distinctive source that I can't seem to manage to locate. Usually shows up in San Bernardino, Kern, or Tulare counties and I've run across several crescents made of this stuff. Finding this one remains one of my top pre-retirement goals!

- Double H-Whitehorse-BS/PP/FM: The elevated Zr nudges this one into a mighty geographically large combined group of N. Nevada and SE Oregon sources.

- Queen/Saline Valley 1 (Queen Impostor): No way I can tell these apart with the Albuquerque analysis although most or all are probably Queen which is much more common. Whenever I run across these two lately, I also analyze some source reference samples with them but even then, the differences are really subtle.

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Table 1. Elemental concentrations for the artifacts and USGS RGM-1 standard. Measurements in parts per million (ppm).

SAMPLE	SOURCE	Rb	Sr	Y	Zr	Nb	Ba	Ti	Mn	Fe	Zn	COMMENTS
DAW1	Rock Canyon I	154	96	18	185	13	1139	1239	321	13320	47	Similar to Casa Diablo (Lookout Mountain) but Ti and Ba are a better fit for Rock Canyon I
DAW2	BS/PP/FM	162	9	59	356	22	0	1189	379	16453	156	Bordwell Spring/Pinto Peak/Fox Mountain
DAW3	Queen/Saline Valley 1 (Queen Impostor)	165	23	23	124	38	24	678	504	10609	49	Can't tell the two apart with Fe:Mn peak ratios
DAW4	Queen/Saline Valley 1 (Queen Impostor)	175	28	26	130	39	49	834	543	11139	70	Can't tell the two apart with Fe:Mn peak ratios
DAW5	Unknown FGV	155	207	13	124	12	36	1097	398	11831	156	FGV - no match with anything in the NWROSL or Berkeley database
DAW6	China Lake Unknown A	105	88	14	50	16	584	710	418	10307	311	California unknown probably located in China Lake region; milky color is key visual characteristic
DD1	Silver Peak	193	72	7	99	15	148	873	402	11035	37	AKA Fish Lake Valley; MZ's similar to South Warners but Ba, Ti, Mn clinch the source
DD2	Bodie Hills	195	110	14	104	15	731	932	438	10836	48	Nice fit
DEW1	Double H-Whitehorse-BS/PP/FM	190	9	74	445	18	19	845	293	15309	197	Ti suggests BS/PP/FM as best choice but close; Double H-Whitehorse is single quite variable source
DEW2	Queen/Saline Valley 1 (Queen Impostor)	173	23	22	127	34	36	667	540	10780	89	Can't tell the two apart with Fe:Mn peak ratios
DEW3	Queen/Saline Valley 1 (Queen Impostor)	175	26	31	139	38	22	779	420	11196	53	Can't tell the two apart with Fe:Mn peak ratios
DEW4	Tempiute Mountain	199	130	34	160	24	678	807	408	12637	79	Nice fit; formerly known as Butte Valley Unknown B in early Nevada XRF studies
DEW5	Unknown Obsidian	165	24	28	127	34	1055	704	515	10656	65	Looks like Queen/SC 1 except for Ba
DS1	Tempiute Mountain	199	132	36	163	28	720	765	437	12635	194	Nice fit; formerly known as Butte Valley Unknown B in early Nevada XRF studies
DS2	Tempiute Mountain	198	131	34	162	26	715	803	432	12627	138	Nice fit; formerly known as Butte Valley Unknown B in early Nevada XRF studies
DS3	Tempiute Mountain	201	136	32	164	28	668	1031	455	12743	85	Nice fit; formerly known as Butte Valley Unknown B in early Nevada XRF studies
DS4	Tempiute Mountain	204	135	35	166	31	677	838	446	12852	84	Nice fit; formerly known as Butte Valley Unknown B in early Nevada XRF studies
DS5	Tempiute Mountain	194	132	33	161	30	742	698	399	12281	140	Nice fit; formerly known as Butte Valley Unknown B in early Nevada XRF studies
DS6	Montezuma Range	334	9	46	107	38	17	484	496	11135	58	Resembles Coso pattern but Montezuma Range is a nice fit
EO1	Mono Glass Mountain	194	10	29	93	26	0	544	313	10991	40	Similar to Fish Springs but Mn makes the call
EO2	Coso (West Sugarloaf)	273	15	58	144	54	7	416	278	12235	138	Classic Coso pattern - Rb and Zr confirm the subsource
EO3	Coso (Sugarloaf Mountain)	237	14	45	110	43	0	327	268	11303	56	Classic Coso pattern - Rb and Zr confirm the subsource
EO4	Coso (West Cactus Peak)	337	12	72	125	74	0	500	287	12031	88	Elevated Rb and Nb confirm
EO5	Coso (Sugarloaf Mountain)	238	10	49	114	40	0	377	262	11280	61	Classic Coso pattern - Rb and Zr confirm the subsource
EO6	Coso (West Cactus Peak)	320	11	69	125	71	0	344	258	11469	75	Elevated Rb and Nb confirm
EO7	Coso (West Sugarloaf)	262	14	55	139	46	0	457	258	11709	59	Classic Coso pattern - Rb and Zr confirm the subsource

SAMPLE	SOURCE	Rb	Sr	Y	Zr	Nb	Ba	Ti	Mn	Fe	Zn	COMMENTS
JG1	Coso (West Sugarloaf)	245	17	51	145	40	33	627	258	12203	63	Classic Coso pattern - Rb and Zr confirm the subsource
JG2	Coso (West Sugarloaf)	272	14	54	136	48	40	499	274	11923	62	Classic Coso pattern - Rb and Zr confirm the subsource
JG3	Coso (West Sugarloaf)	232	18	45	151	41	22	476	262	12020	57	Classic Coso pattern - Rb and Zr confirm the subsource
JG4	Queen/Saline Valley 1 (Queen Impostor)	173	26	28	129	33	20	803	535	10898	63	Can't tell the two apart with Fe:Mn peak ratios
JG5	Mono Glass Mountain	206	17	23	91	31	0	560	338	10324	32	Similar to Fish Springs but Mn makes the call
JG6	Coso (West Sugarloaf)	266	16	55	138	45	14	463	268	12150	64	Classic Coso pattern - Rb and Zr confirm the subsource
JG7	Queen/Saline Valley 1 (Queen Impostor)	180	25	26	127	35	1	701	593	10996	57	Can't tell the two apart with Fe:Mn peak ratios
JG8	Queen/Saline Valley 1 (Queen Impostor)	186	26	27	134	34	9	1048	670	11813	62	Can't tell the two apart with Fe:Mn peak ratios
JG9	Tempiute Mountain	207	135	33	163	29	704	856	459	12830	80	Nice fit; formerly known as Butte Valley Unknown B in early Neva
JG10	Coso (West Sugarloaf)	279	16	56	141	48	17	520	283	12156	66	Classic Coso pattern - Rb and Zr confirm the subsource
RGM1-S4	RGM-1	151	110	24	216	8	805	1651	280	13763	40	standard
RGM1-S4	RGM-1	147	108	28	217	7	803	1603	290	13748	37	standard